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(19) (CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Surfactant Compositions Characterized by Improved Foam Height

(72) Dahanayake, Manilal - U.S.A. ;  
Zhu, Shawn - U.S.A. ;

(71) Rhône-Poulenc Surfactants and Specialties, L.P. -  
U.S.A. ;

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Notice: This application is as filed and may therefore contain an incomplete specification.



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Patent

SURFACTANT COMPOSITION CHARACTERIZED

BY IMPROVED FOAMING

ABSTRACT

A foamable surfactant composition characterized by increased foam height comprising as the surfactant:

- a) a zwitterionic surfactant or
- b) a nonionic alkylphenol ethoxylate surfactant or
- c) a blend of two or more nonionic, anionic, cationic and zwitterionic surfactants in a total amount sufficient to produce a foam in water; and
- d) a polygalactomannan in an amount sufficient to elevate the foam height of an aqueous solution of said surfactant at least 5 millimeters above a control of the surfactant without the polygalactomannan.

These compositions provide increased foam height at the same level of surfactant or the same foam height at a reduced level of surfactant.

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SURFACTANT COMPOSITIONS CHARACTERIZED

BY IMPROVED FOAM HEIGHT

BACKGROUND

Field of the Present Invention

The present invention relates to surfactant compositions characterized by improved foamability allowing for the use of lower amounts of surfactant without sacrificing foamability.

Description of Prior Art

The foaming power of surfactants or their mixtures is an important property that has significant utility in such various areas of use such as personal care products, industrial and institutional products, agricultural, fire fighting and land fill applications. There has been considerable development effort to improve or enhance the foaming power of surfactants or their mixtures for these applications. It is known that it is difficult to improve foam height of an aqueous solution of surfactant or surfactant blend by more than about 5 millimeters by adding another chemical. Usually, solutions of different surfactant mixtures are not synergistic in foaming in that it is difficult for a blend of surfactants to exceed the individual performances provided by each surfactant.

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Foam enhancement is measured in three ways, i.e., foam height quantified by determining the foam height in millimeters after the surfactant solution is dropped into a receiver from a specified height (Ross-Miles foam test); foam density quantified by determining the number of foam cells per given volume; and foam stability also quantified by the Ross-Miles foam test which is expressed in either time (in seconds) required for foam to collapse to 1/2 of its original volume or in foam height (in millimeters) after a given time. The present invention is particularly directed to enhancing foam height.

It is known that in general foaming increases as the concentration of the surfactant increases until a concentration (which is usually greater than the Critical Micelle Concentration or CMC, i.e., the concentration at which micelle formation starts to take place) is attained after which foaming remains essentially constant providing that the solution viscosity has not been elevated to a point where foam height is decreased. In general, high viscosity of the solution will negatively affect foaming.

It is well known that the addition of polygalactomannans, e.g. guar gum, to surfactants will improve foam stability. The amounts of guar gum generally taught as needed to increase foam stability are not known to significantly affect or increase the foam height.

Recognizing the limitations on foaming caused by elevated viscosity, increases in foamability can be accomplished by

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increasing the content of surfactant. However, the greater the amount of surfactant or the greater the stability of the foam, the greater the tendency for the waste water to foam requiring an increase use of defoamers in waste water treatment, either by industry or municipality water treatment systems. An environmentally sensitive foamable product would have the ability to provide desirable foam height with foam stability sufficient for the intended use but using less surfactant such that extensive defoaming prior to waste water treatment is less necessary.

Shampoo formulations containing guar gum(s) among other ingredients are disclosed in EPO Patents 0 231 997 and 0 247 766.

It has now been surprisingly found that surfactants in combination with polysaccharides, e.g., polygalactomannans, in controlled amounts less than that normally used for foam stability will provide increased foaming, i.e., foam height.

#### SUMMARY OF THE INVENTION

In accordance with the present invention, it has now been found that surfactant compositions characterized by improved foamability or foam height can be prepared by a combination of a surfactant(s) with an amount of polygalactomannan which is sufficient to increase foamability, i.e., foam height at least 5 millimeters, preferably at least 7.5 millimeters and more

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preferably at least 10 millimeters over the foam height for the same level of surfactants without added polygalactomannan(s). Surprisingly, the use of lower amounts of polygalactomannans than that taught for increasing foam stability has the unexpected effect of increasing foam height, allowing for the use of less surfactant to achieve a desired foam height.

#### DETAILED DESCRIPTION OF THE DRAWINGS

Figure 1 is a graph showing the effect of a constant amount of a double derivatized guar gum on foam height using varying amounts of a blend of an anionic surfactant with a zwitterionic surfactant against a control with no guar gum.

Figure 2 is a graph showing the effect of varying amounts of a double derivatized guar gum on the foam height of a blend of an anionic surfactant with a zwitterionic surfactant.

Figure 3 is a graph showing the effect of a constant amount of a double derivatized guar gum on the foam height using varying ratios of an anionic surfactant and a cationic surfactant against a control with no guar gum.

Figure 4 is a graph showing the effect of a constant amount of a hydroxypropyl guar gum on foam height using varying ratios of an zwitterionic surfactant and an anionic surfactant against a control

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with no guar gum.

Figure 5 is a graph showing the effect of a constant amount of a 1:1 blend of carboxymethyl guar gum and xanthan gum on foam height using varying amounts of a surfactant blend against a control with no guar gum/xanthan gum blend.

Figure 6 is a graph showing the effect of a constant amount of a carboxymethyl guar gum on the foam height using varying amounts of a surfactant blend against a control with no guar gum.

#### DETAILED DESCRIPTION OF THE INVENTION

##### The Surfactant

The foamable compositions of the invention comprise a surface active composition chosen from cationic, anionic, nonionic, and zwitterionic surfactants or mixtures thereof. The foamable composition can comprise a zwitterionic surfactant (when used as sole surfactant), or blends of one or more further surfactants chosen from the other types and mixtures thereof. It is understood that the surfactants are selected from chemically compatible surfactants as is the practice in the art.

Cationic surfactants are those surfactant compounds having a positive charge on the hydrophilic portion of the molecule. These compounds can be illustrated by alkyl imidazolines, e.g., oleyl imidazoline; ethoxylated amines, e.g., tallow ethoxylated amine, 5

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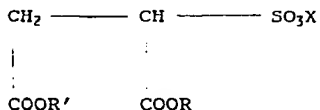
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- 15 EO; imidazoline quats, e.g. ditallow imidazolinium methyl sulfate; benzyl quats, e.g. benzyl trimonium chloride; and tetra alkyl quats, e.g. cetyl trimonium chloride. Some tetra alkyl quats when used as a sole surfactant have been found not to provide foam heights of at least 5 milliliters.

The anionic surface active compound is most preferably an alkyl sulphate, an alkyl ether sulphate or mixtures thereof. Commonly used anionic surface active compounds of these kinds are  $C_{10}$  to  $C_{18}$  alkyl sulphates, and  $C_{10}$  to  $C_{18}$  alkyl ether sulphates containing 0 to 5, preferably 3 or less moles of ethylene oxide. These surfactants are generally employed in the form of their sodium, potassium, ammonium or mono-, di- or tri- ethanolamine salts. Examples of these surfactants are sodium lauryl sulphate, ammonium lauryl sulphate, mono-, di- and tri- ethanolammonium lauryl sulphates, sodium lauryl ether sulphate (2EO), sodium lauryl ether sulphate (3EO), potassium lauryl ether sulphate (2EO) and ammonium lauryl ether sulphate (3EO).

Further suitable anionic surface active compounds include dialkyl sulposuccinates having the structure:



where R and R' represent the same or different straight chain or branched chain alkyl groups having from 5 to 14 carbon atoms and R



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can also equal X; X, is a solubilizing cation chosen from alkali metal, ammonium, substituted ammonium and magnesium.

Particularly preferred dialkyl sulphosuccinates include those where R represents C<sub>6</sub> and/or C<sub>8</sub> alkyl groups.

Still further suitable anionic surface active compounds include  $\alpha$  -olefin sulphonates, alkyl sarcosinates, alkyl monoglyceride sulphates, alkyl monoglyceride sulphonates, alkyl benzene sulphonates, monoalkyl ether sulphosuccinates, alkyl ether carboxylates, mono, and di phosphate esters (alkyl, alkaryl and ethoxylate phosphate esters) including phosphate esters having higher ratios of mono to di, acyl isethionates and acyl methyl taurates.

Nonionic surfactants as those surfactants which have no electrical charge and can be illustrated by alkanolamides, alkyl phenol ethoxylates, fatty acid ethoxylates, alcohol ethoxylates, polyethylene glycol diesters, glycerol esters, galactoside uronates and alkylpoly glycosides. Examples of these nonionic surface active compounds include the reaction product of a sorbitan monolaurate or a sorbitan monococoate with from 20 to 80 moles of ethylene oxide and a C<sub>8</sub> to C<sub>18</sub> ethoxylated fatty alcohol having from 4 to 25 moles of ethylene oxide.

Examples of zwitterionic surfactant compounds, also including those compounds known as amphoterics, include amine oxides, e.g. lauramine oxide; betaines, e.g. alkyl amido betaines such as

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cocamidopropyl betaine, alkyl dimethyl betaine, sulphobetaines, (sultaine, e.g. alkylether hydroxypropyl sultaine such as cocamidopropyl hydroxysultaine) and imidazoline derivatives, e.g., sodium and disodium coco or capryl or tallo or lauro or stearoamphocarboxylates such as acetates, diacetates, propionates and dipropionates, and their acid counterparts, as well as their hydroxyalkyl sulfonates, iminocarboxylates such as acetates, diacetates, propionates and dipropionates, and alkyl glycine, e.g., dihydroxyethyl tallow glycinate.

The amount of surfactant compound present in the foamable compositions of the invention will depend on the product form of the final composition. For example, the foamable product can be in a propellant-free liquid or gel intended to be poured, pumped or otherwise dispensed from a bottle or similar container or from a sachet. The foamable product can also be in the form of a liquid or gel containing a gaseous liquefiable propellant, intended to be dispensed from an aerosol can, such as a mousse.

Generally the surfactant is sufficient in quantity to provide effective foaming for the area of use. Some areas of use require high foaming such as in light duty consumer laundry detergents, carpet cleaners, personal care products including shampoos, bath preparations, liquid soaps, shaving soaps, toilet bars, hair care and grooming products, agricultural and pesticide application foams and fire fighting foams. In general, effective foams can be

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prepared using from about 20% to about 0.01%, and preferably from about 5% to about 0.2% by weight active surfactant in the final foamable composition.

The individual amounts of cationic, anionic, nonionic and zwitterionic surface active compound(s), when present alone or in admixture, will fall within limits for total surfactant compound as defined herein, i.e., from 20% to 0.01%, preferably from 5% to 0.2% by weight of the final composition.

The foam compositions of the invention also comprise a polygalactomannan polymer, either in natural or derivatized form or mixtures thereof. The polygalactomannan gums and their derivatives which can be employed in the invention occur naturally as polysaccharides composed principally of galactose and mannose units. The polygalactomannans are usually found in the endosperm of leguminous seeds, such as guar, locust bean, honey locust, flame tree, Kentucky coffee tree, and the like. The particularly preferred polygalactomannan for use in the process of this invention is guar gum, the principal component of the seed of the guar plant Cyamopsis tetragonalobus.

The basic unit of the galactomannan polymer in guar gum contains two mannose units with a glycosidic linkage and a galactose unit attached to one of the hydroxyls of the mannose unit. On average, each of the sugar units has three available hydroxyl sites, all of which can react. The extent of reaction or

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derivatization of the hydroxyl groups is referred to either as molar substitution (M.S.) which is the number of units (moles of derivatizing agent) which has reacted per sugar unit of the polygalactomannan, or degree of substitution (D.S.0 which is the average number of hydroxy groups of the sugar units that has been reacted with the derivatizing agent.

The guar endosperm as used in this invention is commonly referred to as "purified splits", or double purified splits" depending upon the degree of purification. "Purified splits" are obtained by mechanical separation of the endosperm from the hull and germ of the guar seed in as pure and intact a form as possible with no other processing steps. These purified splits contain, as impurities, about 6-12 percent moisture, 2-7 percent protein and 2-7 percent acid insoluble residue. They have a particle size range of about 4 to about 20 mesh (U.S. Standard Sieve Series).

The guar particles can be reacted with the various derivatizing agents under aqueous alkaline conditions. Any of the alkali metal hydroxides can be used, but the preferred one is sodium hydroxide. Water is the reaction medium used with no organic solvents being necessary in the process.

Derivatives of polygalactomannans, such as the hydroxyalkyl ether, alkyl ether, carboxyalkyl ethers, aminoalkyl ether and quaternary ammonium alkyl ether derivatives, are well known compounds and various methods of preparing the derivatives have

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been described.

The derivatizing agents are the well known alkylating or etherifying agents which contain groups which can react with the hydroxyl groups of the polygalactomannans to form ether groups, such reactive groups being vicinal epoxide groups, halogen atoms, or ethylenically unsaturated groups. Examples of such agents are alkylating agents, hydroxyalkylating agents, carboxyalkylating agents, aminoalkylating agents, quaternary ammonium alkylating agents, cyanoalkylating agents, amidoalkylating agents and the like. Alkylating agents include methyl chloride, methyl bromide, ethyl chloride, ethyl iodide and isopropyl chloride. Hydroxyalkylating agents include ethylene oxide, propylene oxide-1,2, butylene oxide-1,2, hexylene oxide-1,2, ethylene chlorohydrin, propylene chlorohydrin, and epichlorohydrin. Examples of carboxyalkylating agents are chloroacetic acid, chloropropionic acid, and acrylic acid. Aminoalkylating agents include aminoethyl chloride, aminopropyl bromide, N,N-dimethyl-aminopropyl chloride and the like. Quaternary ammonium alkylating agents are such agents as 2,3-epoxypropyl trimethylammonium chloride, 3-chloro-2-hydroxypropyl trimethylammonium chloride and the like. Ethylenically unsaturated group containing agents which react through Michael addition with hydroxyl groups are acrylamide, methacrylamide, acrylonitrile, methacrylonitrile, acrylic acid, sodium acrylate and any of the polymerizable monomers which contain

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one ethylenically unsaturated polymerizable group.

The hydroxyalkyl ethers of polygalactomannans can be prepared by reacting the polygalactomannans with alkylene oxides under basic conditions. In U.S. Patent Nos. 3,723,408 and 3,723,409, guar flour is reacted with alkylene oxides in the presence of water and sodium hydroxide. The reaction product is then neutralized with acid, washed with an alcohol-water mixture, and is then dried and ground. In U.S. Patent No. 3,483,121, the polygalactomannans and the alkylene oxides are reacted under basic conditions with small amounts of water and larger amounts of water miscible or water immiscible organic solvents.

Carboxyalkyl ethers and mixed carboxyhydroxyalkyl ethers of polygalactomannans are described in U.S. Patent Nos. 3,740,388 and 3,723,409, respectively. These derivatizing agents (halofatty acid and alkylene oxide) in a water-alcohol mixture followed by washing with water-alcohol mixtures.

Other derivatives of polygalactomannans are described in such patents as U.S. Patent No. 2,461,502 (cyanoethyl ethers), U.S. Patent No. 4,094,795 (dialkylacrylamide ethers) and U.S. Patent No. 3,498,912 (quaternary ammonium alkyl ethers). In the described processes, the reactions are conducted in water-organic solvent mixtures and the reaction products are washed with solvents or water solvent mixtures.

In order to avoid the use of volatile flammable organic

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liquids and to eliminate the need to recover such organic liquids when the reactions are completed, commercial processes have been developed which use only water as the reaction medium. In such processes, the gum endosperm of the polygalactomannan is reacted with the derivatizing agent under alkaline catalysis using sufficient water to swell the endosperm. The resulting products are then washed to remove unreacted derivatizing agent, caustic, salt and by-products. Borax or aluminum salts can be used to cross-link the gels to avoid forming gels which are extremely difficult to handle and to avoid washing away product.

The polygalactomannans can be classified as nonionic including natural guar gum and hydroxy alkyl ethers; anionic including carboxyalkyl ethers; cationic including quaternary ammonium alkyl ether derivatives; and double derivatives including hydroxalkyl ether/carboxyalkyl ether guar. Polygalactomannan gums are available under the trademark JAGUAR from Rhône-Poulenc.

The guar is generally in powdered form and is hydrated in an aqueous solution of higher concentration before being incorporated into the surfactant solution.

It has also been unexpectedly found that the use of freshly hydrated polygalactomannan compositions, if used within a short period of time from hydration to create a foam, i.e., less than one day, create a greater foam height than an equivalent amount of aged

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polygalactomannan gum. After one day of aging, the effect of the guar on foam height was constant no matter how long the guar solution was aged after hydration. Preferably, the guar gum used to form optimum foam height enhancement has been found to be obtained if the guar gum is used within 3 hours and preferably within 1 hour of hydration. This effect can be particularly useful in industrial and agricultural uses where the polygalactomannan gum can be hydrated at the time of use. Agricultural marking foams, seed treatment foams or pesticide applications foams, land fill foams or fire fighting foams could be more effective with on cite hydration and immediate use. One method of such use is the incorporation of the polygalactomannan in separate pouches either separate from the surfactant(s) or admixed therewith that are dissolved or broken open prior to or during the mixing.

The polygalactomannan gum and/or derivative is present in an amount sufficient to increase foam height and insufficient to cause a decrease in foam height over that obtainable using the surfactant(s) alone. Preferably, the polygalactomannan gum is present in an amount ranging from about 0.005% to about 50%, preferably from about 0.05% to about 15% and more preferably from about 0.02% to about 4% by weight based on the weight of the surface active ingredient(s) (active component) in the foam.

#### Water



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The foaming composition of the invention is an aqueous system and, at the time of foaming, generally contains from about 80% to about 99.95% water. Foamable concentrates can be formed using less water as desired. Foamable concentrates will have the same ratio of polygalactomannan to surfactant as expressed hereinbefore.

#### Optional Ingredients

The foamable compositions of the invention can contain various optional ingredients particularly adapted to provide other effects and which are conventionally employed in the manufacture of like foamable compositions, including but not limited to dyes, perfumes, salts, opacifiers, thickening agents such as water soluble polymers, hair and skin conditioning agents, stabilizers, preservation agents, and the like.

The foamable compositions of the present invention provide high foaming with less surfactant which foams are sufficiently stable for their initial purpose and then are easily broken for ease of disposal, whether in a consumer or industrial environment. The use of less surfactant to achieve an acceptable level of foam in addition to easy foam breaking provides environmentally sound compositions that are easier to dispose of in waste water treatment. These properties make these compositions adaptable for use in products ranging from cosmetics to industrial applications and are usable wherever foamable compositions have found use.

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These products are particularly useful for shampoos, including baby shampoos, body shampoos including bubble baths, bar soaps, bath gels, hair conditioning gels, lotions, skin creams and lotions, make up removal creams and lotions, liquid detergents, dish detergents and other washing and cosmetic products, agricultural marking foams, seed treatment foams, pesticide application foams, land fill foams and fire fighting foams.

The present invention is now more fully illustrated in the examples which follow. The percentage of ingredients of the products prepared in the examples is based on total solution weight and the percentage given in the claims is on a weight basis. The guar gums used in the following experiments were in powdered form and were allowed to hydrate in an aqueous solution of higher concentration before being incorporated into the surfactant solution.

#### EXAMPLE 1

In order to demonstrate the effectiveness of the invention, various surfactant(s) were combined with various guar gums or derivatized guar gums and compared against control formulations containing no guar gums. The amounts of surfactants and guar gum were kept constant.

The surfactants and the polysaccharides studied and reported in these examples are outlined in TABLE I and TABLE II hereinafter:

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TABLE I

Surfactant Class	Surfactant Subclass	Surfactant Trade Name	Surfactant Chemical Name	Surfactant Short Handed Name
Zwitterionics	Amine Oxide	RHADAMOX LO	Lauramine Oxide	LO
	Amphogluccinate	MIRANOL C2M	Sodium Cocoamphodiacetate	C2M
	Amphogluccinate	DV4209 or CMA	Sodium Cocoamphodiacetate	CMA
	Betaine	MIRATAINE CB	Cocoamidopropyl Betaine	CB
	Betaine	MIRATAINE CBC	Cocoamidopropyl Betaine	CBC
	Betaine	MIRATAINE H2C-HA	Sodium Laurylaminodipropionate	H2CHA
	Sultaine	MIRATAINE CBS	Cocamidopropyl Hydroxysultaine	CBS
	Quat	RHODAQUAT M242C/29	Dodecyltrimethylammonium Chloride	DTAC
Anionics	Alkylsulfate	RHODAPON SB8208/s	Sodium Dodecyl Sulfate	SB
	Sulfonate	RHODACAL A246L	Sodium Olefin Sulfonate	A246
	Sulfonate	RHODACAL DS-4	Sodium Dodecyl Benzene Sulfonate	DS-4
	Alkylether Sulfate	RHODAPEX ES	Sodium Laureth (3) Sulfate	ES
	Alkylether Sulfate	RHODAPEX ES2	Sodium Laureth (2) Sulfate	ES2
	Alkylether Sulfate	RHODAPEX ESY	Sodium Laureth (1) Sulfate	ESY
	Alkylphosphate Ester	DV3999	High Monoauryl Phosphate Ester	DV3999
	Taurate	GEROPON T-77	Sodium N-methyl-N Oleoytaurate	T-77
Nonionics	Alkylanolamide	ALKAMIDE DC 212/S	Cocamide DEA (1:1)	DC212
	Ethoxylate	IGEPAL CO-630	Nonylphenol (9EO)	CO630
	Alcohol Ethoxylate	RHADASURF L-4	Lauryl alcohol Ethoxylate	C12E4
Biodegradable	Galactoside Uronate		Sodium Decyl-D Galactoside Uronate	SDDGU
	Glycoside	GLUCOPON 625 CS	Alkyl Polyglycoside	APG625

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TABLE II

Polymer Class	Polymer Subclass	Polymer Trade Name	Polymer Chemical Name	Polymer Short Handed Name
Nonionics	Natural Guar Gum	JAGUAR 2100	Guar Gum	2100
	Modified Guar Gum	JAGUAR 2513	Guar Gum	2513
	Modified Guar Gum	JAGUAR 2638	Guar Gum	2638
	Hydroxypropylated Guar	JAGUAR HP-8	2-hydroxypropyl Ether	HP8
	Hydroxypropylated Guar	JAGUAR HP-120	2-hydroxypropyl Ether	HP120
Anionics	Carboxymethyl Guar	JAGUAR CB-9	Sodium Carboxymethyl Ether	CB-9
Cationics	Cationic Derivative of Hydroxypropyl Guar	JAGUAR C-162	2, Hydroxypropyl 2-hydroxy-3(trimethylammonio) propyl ether chloride	C162
Double Derivative	Hydroxypropyl-carboxymethyl Guar	JAGUAR 8600		8600

Foamability of the product was evaluated using the Ross-Miles Foam Height Test as outlined in ASTM method D1173 and compared to a control system without added polymer, i.e., polygalactomannan. The test comprises dropping a measured amount of surfactant solution from a specific height into a receiver of standard dimensions using a constant volume of solution of 250 milliliters at a constant temperature and recording the initial foam height above 250 milliliters (Initial Foam Height - FHi), the total height of foam above the liquid level at zero minutes (Flash Foam Height - FHF) and the foam height above 250 milliliters after five minutes (Foam Height at 5 Minutes - FH5). The foam was evaluated and the following results were obtained:

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TABLE III

ROSS-MILES FOAM HEIGHT of 1.0% ACTIVE SINGLE SURFACTANT SOLUTIONS  
and THEIR BINARY MIXTURES (0.5% : 0.5%) WITH POLYMER (0.02% AGED  
SOLUTION) and WITHOUT POLYMER AT ROOM TEMPERATURE

## Polymer

Surfactant

No Polymer

Jaguar 2100

Jaguar HP-120

	FHi	FHf	FH5	FHi	FHf	FH5	FHi	FHf	FH5
C2M	168	187	168	172	199	172	168	193	168
CB	170		170	173	195	173	170	197	174
LO	170	185	30	184	205	184	182	201	184
SB	172	199	172						
ES	170	189	170	173	199	173	170	198	170
C2M/A246	176	199	176	178	208	178	172	199	172
C2M/SB	177	209	177	193	229	193	191*	229	191
C2M/ES	174	198	174	176	211	176	175	206	175
C2M/A246	179	205	179	186	220	186	182	215	182
CB/SB	172		172	191	231	191	193*	233	193
CB/ES	173	197	173	180	211	180	176	205	176
LO/SB	160	200	160	191	246	191	191	241	191
LO/ES	171	206	171	194	234	194	190	230	190
LO/A246	170	201	170	192	231	192	189	227	189

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TABLE III (Continued)

ROSS-MILES FOAM HEIGHT of 1.0% ACTIVE SINGLE SURFACTANT SOLUTIONS and THEIR BINARY MIXTURES  
(0.5% : 0.5%) WITH POLYMER (0.02% AGED SOLUTION) and WITHOUT POLYMER AT ROOM TEMPERATURE

Surfactant	Polymer								
	Jaguar 8600			Jaguar CB-9			Jaguar C-162		
	FHi	FHf	FH5	FHi	FHf	FH5	FHi	FHf	FH5
C2M	171	198	171	166	192	166	166	190	166
CB	174	198	174	166	188	168	171		171
LO	186	210	186	185	211	188	175	202	175
SB	176	205	176	175	205	175			
ES	172	198	172	174	202	174	166	192	166
C2M/A246	177	206	177	177	210	177	173	200	173
C2M/SB	190	227	190	187	225	187			
C2M/ES	175	206	175	180	211	180	183	212	183
C2M/A246	183	217	183	188	224	188			
CB/SB	190	230	190	189	229	189			
CB/ES	176	199	176	180	213	180	176	215	180
LO/SB	185	235	185	188	240	188	185	229	185
LO/ES	184	224	184	188	228	188	184	225	184
LO/A246	184	221	184	185	224	185	180	221	180

\*Jaguar HP-8

Note: FHi means initial foam height, FHf means flash foam height, and FH5 means foam height at 5 minutes. The unit for foam height is millimeter.

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**RESULTS****Effect of Added Polymer (0.02% Aged Solution) on the  
Foam Height of Single Surfactant Systems (1% Active).**

Flash foam heights and initial foam heights of amine oxide surfactant solutions (RHODAMOX LO) can be increased by as much as 16 millimeters to 27 millimeters and 12 millimeters to 17 millimeters, respectively, using added polymer such as JAGUAR 1200, JAGUAR HP-120, JAGUAR 8600, JAGUAR CB-9, and JAGUAR C-162 though JAGUAR C-162 enhanced initial foam height by only about 5 millimeters.

Flash foam heights and initial foam heights of nonylphenoxypoly (ethyleneoxy) ethanol surfactant solutions (IGEPAL CO-630) can be increased by as much as 28 millimeters and 22 millimeters, respectively, using 0.02% added polymer such as JAGUAR HP-120, and about 45 millimeters and about 26 millimeters with 0.1% JAGUAR 8600.

Less profound enhancement in flash foam height was found using zwitterionic surfactants such as amphoglacinates (e.g. MIRANOL C2M), anionic surfactants such as alkyl lauryl sulfates (e.g. RHODAPON SB 8208/s) and sulfonates (e.g. RHODACAL A246/L). JAGUAR 2100, and JAGUAR 8600 enhanced the flash foam height of C2M by as much as 12 millimeters and JAGUAR HP-120, JAGUAR CB-9 and JAGUAR C-

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162 by a few milliliters. JAGUAR 2100, JAGUAR HP-120, JAGUAR 8600, and JAGUAR CB-9 enhanced the flash foam height of RHODAPEX ES by about 10 millimeters while JAGUAR C-162 by a few milliliters only. Flash foam height of solutions of RHODAPON SB 8208/s was enhanced by only about 5 millimeters with JAGUAR 8600 and JAGUAR CB-9. JAGUAR 2100, JAGUAR 8600, and JAGUAR CB-9 enhanced the flash foam height of RHODACAL A246/L by about 8 millimeters while JAGUAR C-162 and JAGUAR HP-120 did not affect the flash foam height of solutions of this surfactant.

Small (a few milliliters) or no enhancement in initial foam height was found in zwitterionic surfactants such as amphoglacimates (e.g. MIRANOL C2M), anionic surfactants such as alkyl lauryl sulfate (e.g. RHODAPON SB8208/s) and sulfonates (e.g. RHODACAL A246/L).

Effect of Added Polymer (0.02% Aged Solution) on the  
Foam Height of Binary Surfactant Systems (1% Active).

Flash foam heights and initial foam heights of amine oxide (RHODAMOX LO)/sodium dodecyl sulfate (RHODAPON SB8208/s) surfactant solutions can be increased by as much as 30 millimeters to 46 millimeters and 25 millimeters to 31 millimeters, respectively, using 0.02% added polymer such as JAGUAR 1200, JAGUAR HP-120, JAGUAR 8600, JAGUAR CB-9, and JAGUAR C-162.



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Flash foam heights and initial foam heights of amine oxide (RHODAMOX LO)/sodium laureth (3) sulfate (RHODAPEX ES) surfactant solutions can be increased by as much as 15 millimeters to 28 millimeters and 13 millimeters to 22 millimeters, respectively, using 0.02% added polymer such as JAGUAR 2100, JAGUAR 8600, JAGUAR HP-120, JAGUAR CB-9, and JAGUAR C-162.

Flash foam heights and initial foam heights of amine oxide (RHODAMOX LO)/sodium olefin sulfonate (RHODACAL A246L) surfactant solutions can be increased by as much as 20 millimeters to 30 millimeters and 15 millimeters to 22 millimeters, respectively, using 0.02% added polymer such as JAGUAR 2100, JAGUAR 8600, JAGUAR HP-120, JAGUAR CB-9, and JAGUAR C-162 though JAGUAR C-162 enhanced the initial foam by about 6 millimeters to 10 millimeters.

Flash foam heights and initial foam heights of nonylphenoxypoly (ethyleneoxy) ethanol surfactant solutions (IGEPAL CO-630) can be increased by as much as 28 millimeters and 22 millimeters, respectively, using 0.02% added polymer such as JAGUAR HP-120, and about 45 millimeters and about 26 millimeters with 0.1% JAGUAR 8600.

Flash foam heights and initial foam heights were found enhanced (about 18 millimeters and from about 10 millimeters to about 16 millimeters respectively) using zwitterionic surfactants such as amphoglacinates (e.g. MIRANOL C2M) in combination with anionic surfactants such as alkyl sulfates (e.g. RHODAPON SB 8208/s

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sodium dodecyl sulfate) with 0.02% polymer, e.g. JAGUAR 2100, JAGUAR 2513, JAGUAR 8600, JAGUAR CB-9 and JAGUAR HP-8.

Flash foam heights were found enhanced over the control by about 13 millimeters with JAGUAR 2100, JAGUAR CB-9 and JAGUAR C-162 and by about 7 millimeters with JAGUAR HP-120, and JAGUAR 8600; initial foam heights were found enhanced from about 6 millimeters to about 9 millimeters with JAGUAR CB-9 and JAGUAR C-162 and little or no enhancement with JAGUAR 2100, JAGUAR HP-120, and JAGUAR 8600 using zwitterionic surfactants such as amphoglacimates (e.g. MIRANOL C2M) in combination with alkylether sulfate anionic surfactants such as RHODAPEX ES sodium laureth (3) sulfate.

Flash foam heights were found enhanced over the control by from about 10 millimeters to about 20 millimeters with JAGUAR 2100, JAGUAR 8600 JAGUAR CB-9 and JAGUAR C-120; initial foam heights were found enhanced by about 7 millimeters with JAGUAR 2100 and JAGUAR CB-9 and by a few millimeters with JAGUAR HP-120, and JAGUAR 8600 using zwitterionic surfactants such as amphoglacimates (e.g. MIRANOL C2M) in combination with sulfonate anionic surfactants such as RHODACAL A246L sodium olefin sulfonate.

Flash foam heights were found enhanced over the control by about 15 millimeters with JAGUAR 2100, JAGUAR CB-9, and JAGUAR C-162, and by a few millimeters with JAGUAR 8600 and JAGUAR HP-120; initial foam heights were found enhanced by from about 17

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millimeters to about 21 millimeters with JAGUAR 2100, JAGUAR HP-8, JAGUAR 8600, and JAGUAR CB-9 using zwitterionic surfactants such as betaines (e.g. MIRATAINE CB cocoamidopropyl betaine) in combination with anionic surfactants such as alkyl sulfates (e.g. RHODAPON SB 8208/s sodium dodecyl sulfate).

Initial foam heights were found enhanced by about 7 millimeters with JAGUAR 2100, JAGUAR HP-8, JAGUAR CB-9, and JAGUAR C-162 and little of no enhancement with JAGUAR HP-120 and JAGUAR 8600 using zwitterionic surfactants such as betaines (e.g. MIRATAINE CB cocoamidopropyl betaine) in combination with alkylether sulfate anionic surfactants such as RHODAPEX ES sodium laureth (3) sulfate.

#### EXAMPLE 2

Other surfactants were studied as per the procedure of EXAMPLE 1 with the following results:

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TABLE IV

Others:

wt%	Surf1	wt%	Surf2	wt%	Guar	FHi	FHf	FHS
0.32	CB	+0.17	ESY	+0.013	CB-9	186		186
0.32	CB	+0.17	ES2	+0.013	CB-9	182		182
0.32	CB	+0.17	DS-4	+0.013	CB-9	182		182
0.32	CB	+0.17	A246	+0.013	CB-9	186		156
0.5	CMA					161		161
0.25	CMA	+0.25	SB	+0.013	CB-9	186		186
0.05	C2M	+0.05	SDDGU	+0.02	CB-9	160		183
0.05	C2N	+0.05	SDDGU			156		156
0.1	C2M					151		151
0.1	SDDGU					146		146
0.25	CMA	+0.25	SB	+0.02	HP8	188		188
0.5	CBC	+0.5	SB			175		175
1	CBC					170		180
0.5	CBC	+0.5	SB	+0.013	CB-9	188		183
0.75	CMA					182	178	163
0.75	SB					171	193	171
0.375	CMA	+0.375	SB			171	195	171
0.375	CMA	+0.375	SB	+0.008	R-23	175	209	175
0.5	CMA	+0.5	SB	+0.011	8600	186	220	184
1	CO630					145	157	137
0.5	LO	+0.5	CO630			173	191	30
0.5	LO	+0.5	CO630	+0.01	8600	183	205	183
1	H2CHA					166	182	166
1	T77					156	176	156
0.5	H2CHA	+0.5	T77			161	179	161
0.5	H2CHA	+0.5	T77	+0.01	8600	169	189	169
1	L22					179	206	179
1	DC212					151	178	151
0.5	L22	+0.5	DC212			172	202	172

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0.5	L22	+0.5	DC212	+0.01	8600	182	210	182
0.5	CBC	+0.5	ES	+0.01	CB-9	180	211	180
0.45	CBC	+0.45	SB	+0.02	CB-9	183	221	183
0.62	C2M	+0.48	SB	+0.02	Meth	170	204	170

**EXAMPLE 3**

The foam heights obtained using a 1:1 binary system of an alkyl sulfate anionic surfactant (e.g. RHODAPON SB8208/s sodium dodecyl sulfate) in combination with an amine oxide cationic surfactant (RHODAMOX LO - lauramine oxide) with a double derivatized guar gum (JAGUAR 8600) were studied and the data reported in TABLE V which shows the results obtained by varying the amount of surfactant while keeping the guar gum constant at 0.01%, the guar gum being aged less than 7 hours (data represented in Figure 1), by varying the amount of guar gum, the guar gum being aged less than 7 hours, while keeping the surfactant blend amount constant at 0.5% by weight (data represented in Figure 2), and by varying the ratio of surfactants whereby an alpha of zero means 0% RHODAPON SB8208/s and 100% RHODAMOX LO and an alpha of one means 0% RHODAMOX LO and 100% RHODAPON SB8208/s with decimal figures in between equaling varying ratios of the two while keeping the guar gum constant at 0.01%, the guar gum being aged less than 5 hours (data represented in Figure 3).

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**TABLE V**

Foam Height Comparisons Using A Constant Amount Of A Double Derivatized Guar Gum While Varying The Ratio Of An Anionic Surfactant SB 8208/s And A Cationic Surfactant Lo

Foam Height for RHODAPON SB 8208/RHODAMOX LO/JAGUAR 8600

1 wt% active surfactant, 0.01% Guar

wt% Surf	$\alpha$	wt% Guar	FHi	FHf	FHS	pH
1	1	0.01	190	223	190	8.9*
1	0.5	0.01	202	252	202+6	9.25
1	0	0.01	187	211	170	6.9
1	1		170			8.9**
1	0.5		160	200	160	9.25
1	0		170	185	30	7.1
0.5	1	0.01				***
0.5	0.5	0.01	200	250	202	
0.5	0	0.01				
0.5	0.5	0.005	195	245	165	
0.5	1		170			
0.5	0.5	0	162	202	162	
0.5	0					
0.25	1	0.01				
0.25	0.5	0.01	192	242	192	
0.25	0	0.01				
0.25	1					
0.25	0.5		165	207	165	
0.25	0					
0.125	1	0.01				
0.125	0.5	0.01	183	228	183	
0.125	0	0.01				
0.125	1					
0.125	0.5		166	204	166	
0.125	0					

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\*All the foam has maximum at the center

\*\*Very dense foam

\*\*\*16 hours later still 197mm

EXAMPLE 4

The process of Example 1 was repeated using varying ratios of an a cocoamidopropyl betaine zwitterionic surfactant (MIRATAINE CB) and a sodium dodecyl sulfate anionic surfactant (RHODAPON SB8208/s) using 0.02% of a nonionic hydroxypropyl guar (JAGUAR HP-8) at pH 6 and 25°C against a non guar-containing control. The total active surfactant level was 0.5 weight %. The results are shown FIGURE 4.

EXAMPLE 5

Foam heights were obtained using a tertiary blend of surfactants, i.e., 0.5% lauryl alcohol ethoxylate (RHODASURF L-4), 0.29% sodium cocoamphodiacetate (MIRANOL C2M) and 0.21% sodium dodecyl sulfate (RHODAPON SB8208/s) plus 0.02% sodium carboxymethyl guar (JAGUAR CB-9) and compared to a control. The foam heights in millimeters were 179 for initial and 5 minute with 211 for flash. The control showed initial and 5 minute foam heights of 171 millimeters and a flash foam height of 199 millimeters.

EXAMPLE 6

Foam heights were obtained using a 10% of a surfactant blend that is a tertiary blend of surfactants, i.e., cocoamphodiacetate, sodium lauryl sulfate and sodium laureth sulfate (47% actives) plus 0.02% sodium carboxymethyl guar (JAGUAR CB-9). Flash foam height was increased by 16 millimeters while initial foam height was increased by 9 millimeters as compared to a control.

EXAMPLE 7

Foam heights were obtained using from 10% to 0.25% of a surfactant blend that is a tertiary blend of surfactants, i.e., cocoamide - diethanolamide 1:1, sodium laureth sulfate and cocamidopropyl betaine (47% actives) plus 0.01% sodium carboxymethyl guar (JAGUAR CB-9) and 0.01% xanthan gum. Flash foam height was enhanced by 30 to 35 millimeters while initial foam height was increased by 10 to 25 millimeters as compared to a control. This data is reported in FIGURE 5.

Using a 4.5% solution, initial foam height was enhanced by about 14 to 20 millimeters and flash foam height by about 16 60 19 millimeters using 0.02% JAGUAR C-162 or JAGUAR 8600.



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EXAMPLE 8

Foam heights were obtained using from 20% to 1.0% of a surfactant blend, i.e., 45 parts sodium lauryl sulfate, 8 parts ethylene glycol monobutyl ether, 8 parts sodium laureth (3) sulfosuccinate, 3 parts C<sub>12</sub>-C<sub>16</sub> alcohol, 5 parts cocamide MEA, 25 parts ammonium salt of sulfated C<sub>8</sub>-<sub>10</sub> ethoxylate as active materials plus 0.02% sodium carboxymethyl guar (JAGUAR CB-9). Flash foam height was enhanced by 48 to 16 millimeters while initial foam height was increased by 38 to 8 millimeters as compared to a control. This data is reported in FIGURE 6.

Various modifications can be made in the details of the various embodiment of the compositions and processes of the present invention, all within the spirit and scope of the invention as defined by the appended claims.

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WHAT IS CLAIMED IS:

1. A foamable surfactant composition characterized by increased foam height comprising:
  - a) a zwitterionic surfactant as the sole surfactant in an amount sufficient to produce a foam in water; and
  - b) a polygalactomannan including mixtures thereof in an amount sufficient to elevate the initial foam height of an aqueous solution of said zwitterionic surfactant at least 5 millimeters above a control of the surfactant without the polygalactomannan using the Ross-Miles foam test.
2. A foamable surfactant composition characterized by increased foam height comprising:
  - a) a nonionic alkylphenol ethoxylate surfactant as the sole surfactant in an amount sufficient to produce a foam in water; and

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- b) a polygalactomannan including mixtures thereof in an amount sufficient to elevate the initial foam height of an aqueous solution of said nonionic surfactant at least 5 millimeters above a control of the surfactant without the polygalactomannan using the Ross-Miles foam test.
3. A foamable surfactant composition characterized by increased foam height comprising as the surfactant:
- a) a blend of two or more nonionic, anionic, cationic and zwitterionic surfactants in a total amount sufficient to produce a foam in water; and
  - b) a polygalactomannan including mixtures thereof in an amount sufficient to elevate the initial foam height of an aqueous solution of said blend of surfactants at least 5 millimeters above a control of the blend of surfactants without the polygalactomannan using the Ross-Miles foam test.
4. A foamable surfactant composition as recited in Claim 1 wherein said polygalactomannan is a guar gum or derivative thereof.

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5. A foamable surfactant composition as recited in Claim 2 wherein said polygalactomannan is a guar gum or derivative thereof.

6. A foamable surfactant composition as recited in Claim 3 wherein said polygalactomannan is a guar gum or derivative thereof.

7. A foamable surfactant composition as recited in Claim 1 wherein said surfactant is an alkylamine oxide.

8. A foamable surfactant composition as recited in Claim 3 wherein one of said surfactants is an alkyl sulfate anionic surfactant.

9. A foamable surfactant composition as recited in Claim 3 wherein one of said surfactants is a betaine based zwitterionic surfactant.

10. A foamable surfactant composition as recited in Claim 3 wherein one of said surfactants is an amphoglacinate surfactant.

11. A foamable surfactant composition as recited in Claim 3 wherein one of said surfactants is an alkylamine oxide cationic surfactant.

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12. A foamable surfactant composition as recited in Claim 3 wherein one of said surfactants is an alkylether sulfate anionic surfactant.

13. A foamable surfactant composition as recited in Claim 3 wherein said surfactant blend is used in an amount ranging from about 0.01% to about 20% of the final foam.

14. A foamable surfactant composition as recited in Claim 3 wherein said surfactant is a blend of zwitterionic and anionic surfactants.

15. A foamable surfactant composition as recited in Claim 3 wherein said surfactant is a blend of amine oxide surfactants and sodium lauryl sulfate.

16. A foamable surfactant composition as recited in Claim 3 in concentrated form wherein said surfactant blend is used in an amount ranging from about 0.01% to about 20% of the final composition and the polygalactomannan ranges from about 0.0005% to about 50%.

17. A foamable surfactant composition as recited in Claim 3 wherein the polygalactomannan on a non-aqueous basis is used in an

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amount ranging from about 0.005% to about 50% based on the weight of the surfactants.

18. A foamable surfactant composition as recited in Claim 3 wherein said polygalactomannan is aged less than 24 hours after hydration before making the composition into a foam.

19. A foamable surfactant composition as recited in Claim 3 wherein said polygalactomannan is aged less than 3 hours after hydration before making the composition into a foam.

20. A foamable surfactant composition as recited in Claim 3 wherein said polygalactomannan is aged less than 1 hour after hydration before making the composition into a foam.

21. A foamable surfactant composition characterized by increased foam height comprising as the surfactant:

- a) a surfactant or blend of two or more nonionic, anionic, cationic or zwitterionic surfactants in a total amount sufficient to produce a foam in water; and
- b) a polygalactomannan including mixtures thereof in an amount sufficient to elevate the initial foam height of an aqueous solution of said blend of surfactants at least

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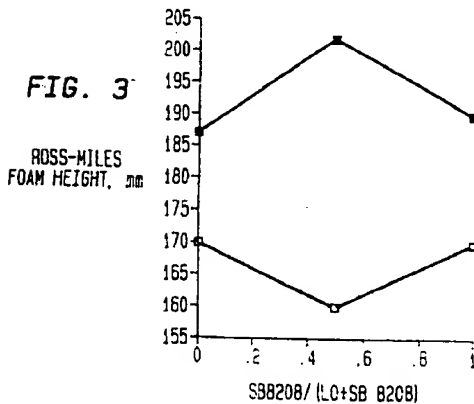
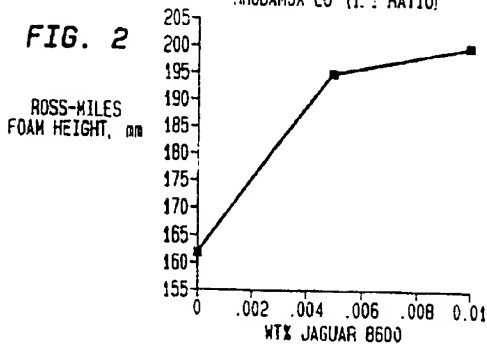
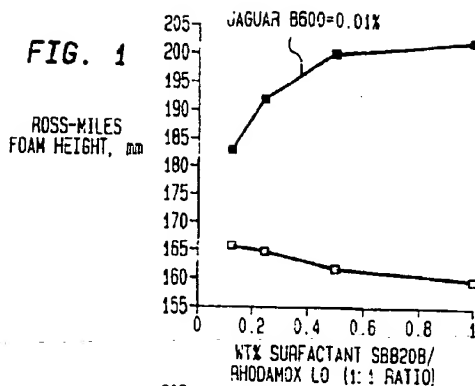
5 millimeters above a control of the blend of surfactants without the polygalactomannan using the Ross-Miles foam test wherein said polygalactomannan is aged less than 24 hours after hydration before making the composition into a foam.

22. A foamable surfactant composition as recited in Claim 21 wherein said polygalactomannan is aged less than 3 hours after hydration before making the composition into a foam.

23. A foamable surfactant composition as recited in Claim 21 wherein said polygalactomannan is aged less than 1 hour after hydration before making the composition into a foam.

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FIG. 4

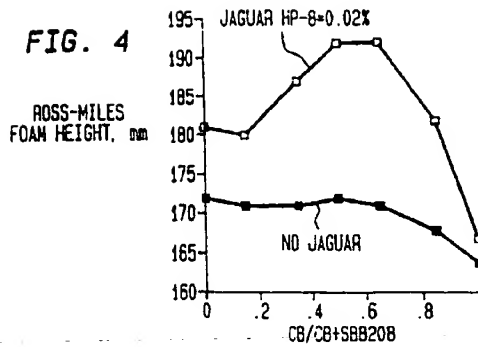


FIG. 5

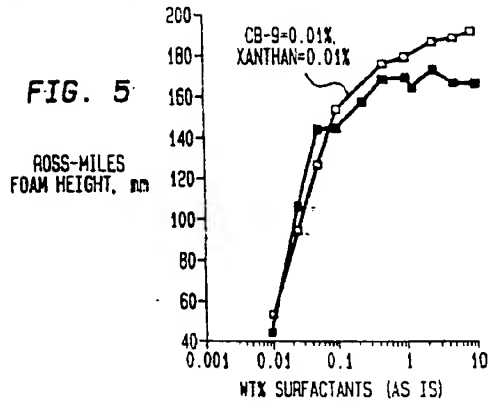
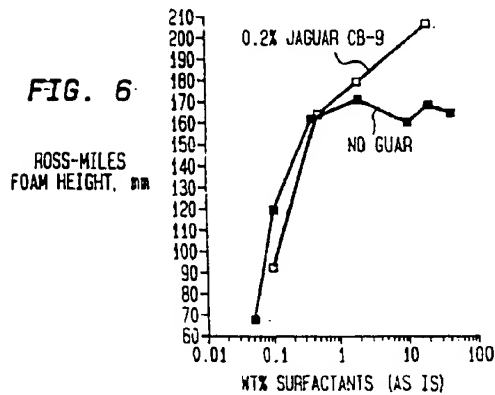


FIG. 6



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